Pesticide Environmental Stewardship Program

Final Report

Development and Implementation of Mid-Season, Reduced-Input Disease and Insect IPM Options for Southeastern Peaches

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4 years (PESP funds for first 2 years)

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$39,997.-

RATIONALE:

Pest management is a major expense in peach production. While southeastern producers are generally successful in minimizing damage due to insects and diseases, certain pesticide applications could be reduced and/or better timed, thus lowering cost of production and improving control efficacy while at the same time reducing potentially negative environmental impacts. Reduced-input pest management may be accomplished through strategies such as extended spray intervals or alternate-row middle (ARM) spraying during periods with reduced pest pressure. Pesticide application timing may be optimized through pest prediction models.

The most promising candidates for <u>reduced-input spray programs</u> in peach are scab (*Cladosporium carpophilum*) and plum curculio (*Conotrachelus nenuphar*) during mid-season (after third or fourth cover) when population numbers of the two pests tend to decrease markedly. Research on mid-season ARM spraying against scab has been conducted in Georgia since 1997 in both research orchards and on commercial farms, with very promising results. In 1999, this work was extended to include plum curculio.

One of the most promising candidates for a <u>pest prediction model</u> is the plum curculio. During mid-season, growers presently must apply multiple insecticide sprays targeted primarily against the "June" generation of this insect. If growers could better anticipate the timing of this generation in their orchards, the number of mid-season insecticide applications could be reduced. In the absence of reliable monitoring techniques for plum curculio, development of a predictive model offers the greatest potential for precise, commercially feasible insecticide spray timing.

OBJECTIVES:

Our overall goal is the development of IPM options for scab and plum curculio, two key pests of peach in Georgia, based on reduced and/or better timed pesticide applications. Specific objectives include 1) evaluate ARM spray application for scab and plum curculio control during mid-season; and 2) develop a degree-day model for predicting plum curculio activity to optimize spray timing.

RESULTS:

ARM evaluation in research orchard. Evaluation of mid-season ARM spray schedules for scab and plum curculio was conducted in a research orchard cv. 'Blake' in 1999 and 2000. The trial involved the following treatments (Table 1): 1) untreated control; 2) standard applications of fungicide and insecticide; 3) standard fungicide, no insecticide; 4) no fungicide, standard insecticide; 5) standard fungicide, ARM insecticide; 6) ARM fungicide, standard insecticide; and 7) ARM fungicide, ARM insecticide.

The <u>standard</u> strategy for fungicide involved applications of Captan (5 lbs/A) at shuck split and shuck fall, followed by sulfur (10 lbs/A) at ca. 2-week intervals from third cover. In 1999, the insecticide standard included alternating of Imidan (2 lbs/A) and Penncap-M (2.25 pts/A) starting at petal fall, with subsequent applications at shuck split, shuck fall, and continued at ca. 2-week intervals throughout the season (same timing as fungicides); in 2000, Imidan was the only insecticide used. Standard sprays were applied with an airblast sprayer at 60 gal/A, with a spray pressure of 150 psi and a tractor speed of 4 mph.

For the ARM treatments, applications were identical to the standard until third cover. After third cover, sprays were applied only to every other tree row, using the same spray timing and chemicals as for the standard. Spray parameters were identical to the standard, except that tractor speed was reduced from 4 to 3 mph to increase coverage; thus, the ARM strategy applied 40 gal of spray per acre: 60 gal/A divided by 2 (because only every other row was sprayed) and multiplied by 4/3 (because tractor speed was reduced from 4 to 3 mph). The concentration of pesticide in the spray tank remained unchanged compared with the standard, except for sulfur, in which case it was increased 1.5-fold.

In both years, the experimental design was a randomized complete block with four replicates. Plot size was four rows wide by five trees long.

When fruit were firm-ripe, 120 fruit per plot were assessed for scab incidence (percent fruit with at least one lesion) and scab severity (percent of surface area covered with lesions) as well as the incidence of insect injury. Fruit were further graded individually for scab and insect injury using official USDA grading standards.

1999. For scab, the results showed that the plots receiving mid-season ARM sprays (treatments 6 and 7; severity range 0.26-0.32%) gave a level of control equivalent to the standard (treatments 2, 3, and 5; range 0.33-0.44%), although scab pressure in the orchard was very high (100% scab incidence in treatments 1 and 4 which did not receive fungicide) (Table 2). This good level of scab control corroborates results obtained in our 1997 and 1998 ARM trials in research and commercial orchards.

The results were similar for insect injury, with the plots receiving mid-season ARM insecticide sprays (treatments 5 and 7; incidence range 13-20%) not being different from those receiving the standard program (treatments 2, 4, and 6; range 11-24%), despite the use of 1/3 less insecticide during mid-season. The plots without any insecticides (treatments 1 and 3) had a significantly higher incidence of insect scars (Table 2). Insecticide reductions such as those obtained in this trial are very important in the current regulatory environment, with the continuous threat to growers of losing additional active ingredients, particularly among the organophosphates and carbamates.

Fruit quality, graded according to USDA standards, was similar in the treatments receiving standard pesticide applications and those receiving mid-season ARM applications (compare treatments 5, 6, and 7 with treatment 2 in Fig. 1).

2000. Scab pressure was much lower in 2000 than in 1999, presumably because of dry conditions during much of spring and summer of 2000. Fruit scab severity was significantly lower in all plots receiving fungicides compared with those that remained unsprayed with fungicide (treatments 1 and 4). ARM fungicide sprays (treatments 6 and 7) gave a level of scab control not significantly different from conventional fungicide sprays (treatments 2, 3, and 5), with fruit from all these treatments having only traces of scab (Table 2).

Similar to scab, insect injury was much lower in 2000 than in 1999, presumably because a large area of the orchard that was to have remained unsprayed with insecticide to serve as an ‘insect reservoir’ was erroneously treated during early-season. Although plots without any insecticides (treatments 1 and 3) had a higher incidence of insect scars (>3%), this level was not significantly different from plots receiving mid-season ARM insecticide sprays (treatments 5 and 7) or those receiving conventional insecticide sprays (treatments 2, 4, and 6). All plots treated with insecticide showed only traces of insect scarring (Table 2).

Fruit quality, graded according to USDA standards, was similar in the treatments receiving standard pesticide applications and those receiving mid-season ARM applications (compare treatments 5, 6, and 7 with treatment 2 in Fig. 1).

ARM evaluation in commercial orchards. The ARM approach was further evaluated in two commercial orchards in middle Georgia (Crawford County) in 1999 and 2000 using a simplified experimental design consisting of only two treatment strategies. It included a comparison of the grower's standard practice (standard application of his pesticides and application intervals of choice) with mid-season ARM applications of the same pesticides at the same concentration and at the same spray timing in large, non-replicated plots (12 tree rows wide, entire orchard length); the cultivars were 'Sunprince' and 'O'Henry'. In both cultivars and years, ARM spraying was initiated after fourth cover when scab and plum curculio pressures were expected to have decreased. At the time of commercial harvest, 120 to 150 fruit were sampled from each plot in each cultivar and assessed as described for the research orchard. Data on scab severity and insect scar incidence were analyzed using analysis of variance, whereby the different cultivars and years were treated as blocks.

Only traces of scab were observed in the two treatments in both years. Across both years and cultivars, average scab severity (percent surface area covered with lesions) in the grower's standard (0.017%) was not significantly different from the ARM plots (0.021%) (P = 0.1557). Similar results were obtained for the incidence of fruit with scarring (percentage of fruit having at least one insect scar); on average, standard plots had 0.5 scarred fruit in a fruit sample of 120, while ARM plots had 1.0 scarred fruit in the same sample (P = 0.2315). Analysis of pesticide use, economics, and environmental impacts associated with the two spray strategies are still ongoing.

Plum curculio model development. The overall goal of this part of the study is to develop a degree-day model for the plum curculio's June generation. Model development will be based mainly on laboratory rearing studies at constant and fluctuating temperatures. We anticipate that an operational model for plum curculio prediction will consist of two key components:

1. Monitoring of immigration into the orchard of overwintering plum curculios in early spring with Tedders weevil traps.
2. Subsequent use of a degree-day model to predict the insect's generation time (from adult to adult) and thus anticipate the onset of the June generation.

Thus, the arrival of the overwintering generation (as monitored with the traps) could serve as a starting point (biofix) from which to run the degree-day model for the June generation. Note that we are not attempting to predict the onset of the overwintering generation in early spring; representatives of this generation do not cause important damage and are readily controlled with petal fall sprays.

Monitoring. In 1999, season-long plum curculio monitoring was conducted in three research orchards in northern Georgia, middle Georgia, and northern Florida. Tedders weevil traps and cone emergence traps were placed near the orchard borders or near brush piles where the number of immigrating, overwintering plum curculios was expected to be greatest. Traps were inspected at 1- to

3-day intervals throughout the season, and plum curculios were removed and counted during each inspection. In 2000, similar monitoring was carried out with Tedders traps. In addition, emergence of the June generation was monitored directly by placing plum curculio-infested green fruit on the ground under cone emergence traps, allowing the larvae to exit the fruit and pupate in the ground; and catching emerging adults in the traps; this was done in middle Georgia, northern Georgia, and South Carolina. This was done in close collaboration with entomologists in South Carolina, Florida, and Georgia. The data sets obtained from detailed population monitoring, when continued over multiple years and locations, will be invaluable for validating the laboratory-based plum curculio model (see below).

Model development. In 1999 and 2000, infested green fruit were collected in middle Georgia and in South Carolina to establish plum curculio laboratory colonies. The rearing process followed a protocol developed by USDA-ARS in Byron, whereby the larvae were allowed to emerge from the infested fruit in a funnel before being transferred into a jar with moist potting soil. Larvae were allowed to pupate, after which emerging adults were collected and placed in closed cages for mating and oviposition into thinning apples. While rearing was only partly successful in 1999, the two colonies were successfully established and maintained during the summer and fall of 2000.

Populations of the insect at different life stages were exposed to constant temperatures of ca. 15, 20, 25, 30 and 35ºC in the laboratory and naturally fluctuating temperatures in the greenhouse and outdoors. For each temperature regime, plum curculio development times from oviposition to larval emergence and from larval emergence to adult emergence were recorded. As of this writing, four to six replicates of each temperature regime have been obtained.

Development times from oviposition to larval emergence. Speed of larval development and the number of emerging larvae was strongly temperature-dependent (Fig. 2), suggesting great promise for our overall goal of developing a temperature-based (degree-day) model. No larvae emerged from thinning apples incubated at 15ºC. Between 20 and 35ºC, larvae began to emerge earlier as temperature increased. The number of emerging larvae was greatest at 30ºC, but large numbers were also observed at 20 and 25ºC. Although larvae emerged earliest at 35ºC, their total number at this temperature was very low (Fig. 2). Frequency distributions of larval emergence tended to be more skewed at lower temperatures.

Development times from larval emergence to adult emergence. No plum curculio adults emerged when pupation jars were exposed to 15 or 35ºC. Between 20 and 30ºC, adults began to emerge earlier as temperature increased,.The number of emerging adults was greatest at 25ºC, suggesting that the temperature optimum for pupal development is lower than that for larval development.

Once all replications of the various temperature regimes have been completed, development times for the periods from oviposition to larval emergence and from larval emergence to adult emergence will be expressed as heating degree-days to facilitate prediction of the plum curculio's generation time in relation to environment.

CONCLUSIONS:

Results obtained with mid-season ARM spraying of fungicides and insecticides against both scab and plum curculio in experimental and commercial orchards in 1999 and 2000 were very promising, with no differences in fruit quality between the standard and ARM schedules. This corroborates our favorable experience with mid-season ARM scab sprays in 1997 and 1998. We feel now confident in recommending this approach for commercial use after third or fourth cover, assuming the application intervals are not spaced more than about 2 weeks apart.

Model development for the plum curculio is on track. A data base for modeling is being generated using development time studies in constant and fluctuating temperatures. Detailed population monitoring of the insect in unsprayed orchards in past and future years will provide independent data sets for validating the laboratory-based plum curculio model.

Table 1. Pesticide application strategies against peach scab and plum curculio in a research orchard (cv. 'Blake') in northern Georgia in 1999 and 2000

Treatment	Application time				
	Petal fall	Shuck split	Shuck fall	Third cover	Fourth cover to preharvest
1 (Control)	--	--	--	--	--
2 (Standard)	Imidan	Penncap-M[a] Captan[b]	Penncap-M Captan	Imidan Sulfur[c]	Penncap-M/ Imidan[d] Sulfur
3	--	Captan	Captan	Sulfur	Sulfur
4	Imidan	Penncap-M	Penncap-M	Imidan	Penncap-M/ Imidan
5	Imidan	Penncap-M Captan	Penncap-M Captan	Imidan Sulfur	**Penncap-M/ Imidan applied ARM**[e] Sulfur
6	Imidan	Penncap-M Captan	Penncap-M Captan	Imidan Sulfur	Penncap-M/ Imidan **Sulfur applied ARM**
7	Imidan	Penncap-M Captan	Penncap-M Captan	Imidan Sulfur	**Penncap-M/ Imidan applied ARM** **Sulfur applied ARM**

[a] In 1999, Imidan 70 WP and Penncap-M 2FM (maximum of four complete applications) were applied at 2 lbs/A and 2.25 pts/A, respectively. In 2000, only Imidan was used.
[b] Captan was applied at 5 lbs/A.
[c] Wettable sulfur was applied at 10 lbs/A.
[d] In 1999, Penncap-M and Imidan were alternated beginning at fourth cover because only four complete applications of Penncap-M were allowed.
[e] ARM = alternate-row middle application. Spray parameters were identical to the standard, except that only every other row was sprayed and tractor speed was reduced from 4 to 3 mph to increase coverage. The concentration of pesticide in the spray tank remained unchanged, except for sulfur, in which case it was increased 1.5-fold.

Table 2. Scab severity and incidence of insect injury following various pesticide application strategies in a research orchard (cv. 'Blake') in northern Georgia in 1999 and 2000

		1999		2000	
Trtmt.[a]	Treatment strategy[b]	Scab severity (%)[c]	Incidence of fruit with insect injury (%)[c]	Scab severity (%)	Incidence of fruit with insect injury (%)
1	Untreated control	9.96 a	32 a	1.03 a	3.54 a
2	Standard fungicide, standard insecticide	0.33 b	24 ab	0.02 b	0 a
3	Standard fungicide, no insecticide	0.34 b	33 a	0.01 b	3.75 a
4	No fungicide, standard insecticide	10.78 a	11 b	1.22 a	0 a
5	Standard fungicide, ARM insecticide	0.44 b	20 ab	0.01 b	0.83 a
6	ARM fungicide, standard insecticide	0.32 b	14 b	0.04 b	0 a
7	ARM fungicide, ARM insecticide	0.26 b	13 b	0.03 b	0.83 a

[a] See Table 1 for further explanation of the treatments.
[b] ARM = alternate-row middle application.
[c] Means followed by the same letter within a column are not significantly different at P=0.05 (Tukey's test).

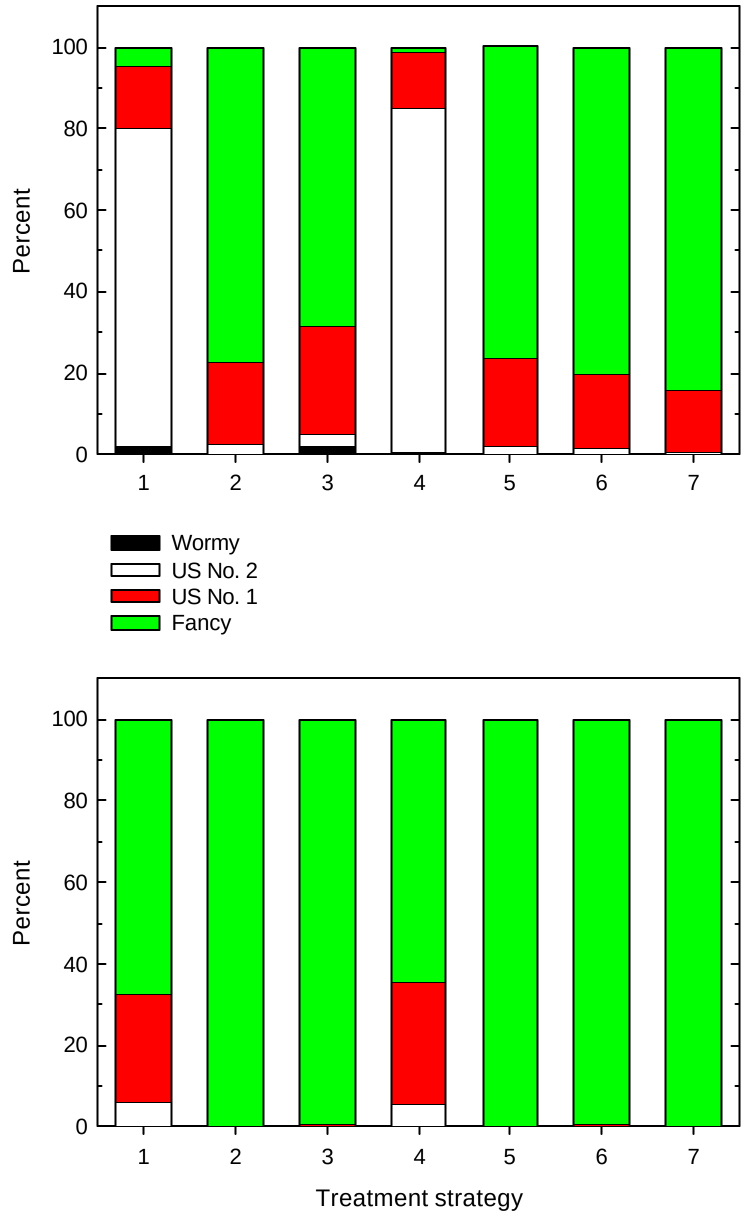

Figure 1 Percent peach fruit graded into different USDA quality categories based on intensity of scab and insect injury following various pesticide application strategies in a research orchard (cv. 'Blake') in northern Georgia in 1999 (top) and 2000 (bottom). The treatment strategies were: 1) untreated check; 2) standard application of fungicide and insecticide; 3) standard fungicide, no insecticide; 4) no fungicide, standard insecticide; 5) standard fungicide, ARM insecticide; 6) ARM fungicide, standard insecticide; and 7) ARM fungicide, ARM insecticide (see Table 1 for further explanation of the treatments). ARM = alternate-row middle application.

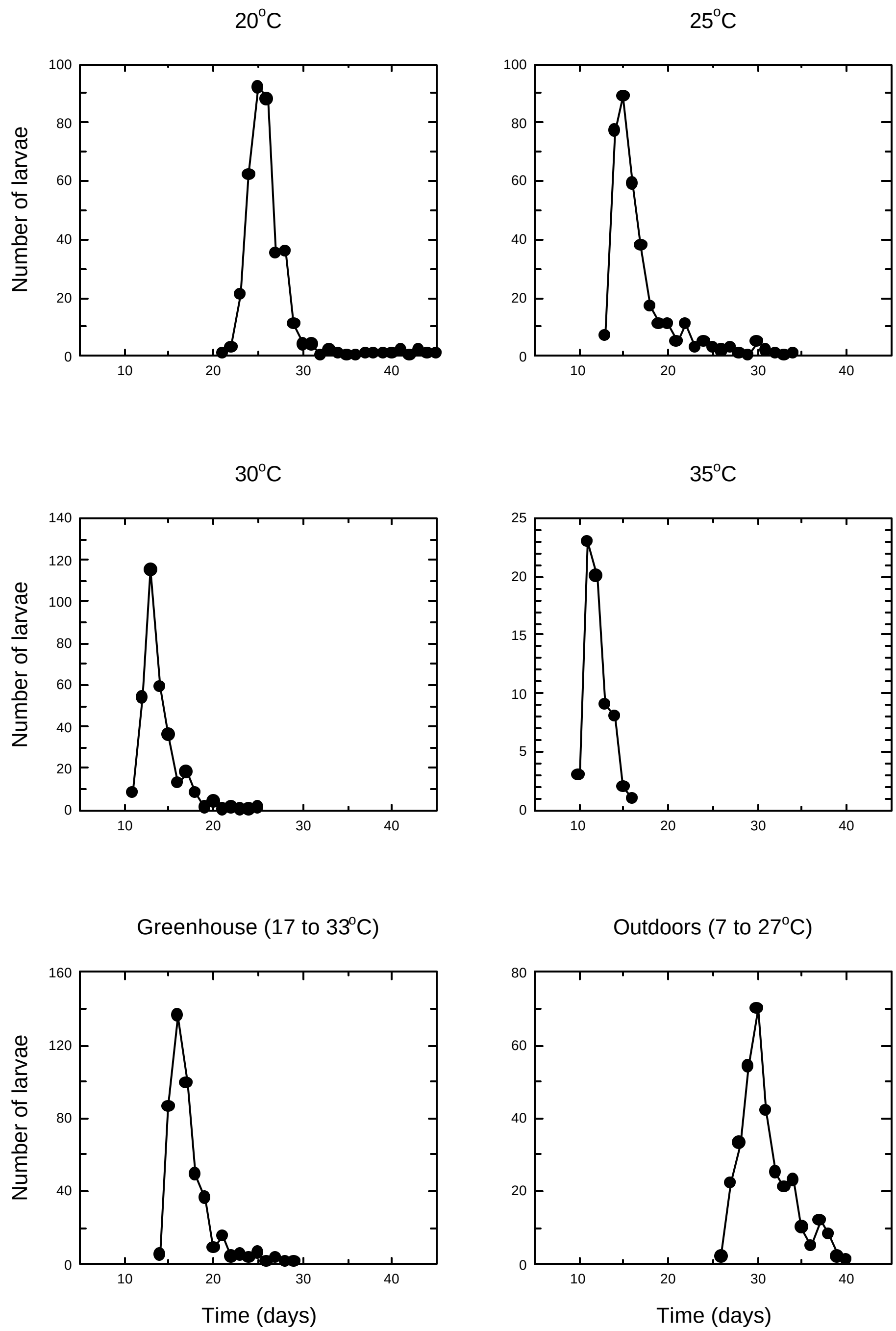

Figure 2 Development times from oviposition to larval emergence for a plum curculio colony in relation to different constant and fluctuating temperature regimes. The colony was originally established from larvae collected near Byron during the summer of 2000. Four to six replications of each temperature regime have been completed, but only one replication is shown. Similar data sets have been obtained for development times from larval emergence to adult emergence (*data not shown*).